



U.S. Department of Energy
Energy Efficiency and Renewable Energy

Photovoltaic Technologies

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Meeting Future Energy Demand with Renewables

- By 2050, some fossil fuel companies expect the world to double its energy demand.
- The earth receives as much energy from sunlight in 20 days as is believed to be stored in this planet's entire reserves of fossil fuels.
- People are unlikely to tolerate increased pollution, extra infrastructure and the possible effects on the climate.



Turning Sunlight into Electricity

- Photovoltaic (PV) cells are made from materials that are neither insulators nor conductors of electricity—"semi-conductors"—such as silicon.
- The electrons in a semiconductor material live in a range of defined energy levels, or bands, partially filled with electrons, creating a negative charge.
- Electrons move down an external circuit in the form of light-generated electricity: the "photovoltaic effect."



Electricity Generation Quantities



- 15% of the energy of sunlight can be used to produce electricity using PV technology.
- PV cell size determines the amount of current and power it is capable of producing - at most some 0.5 Volts (V).
- Output between 20 - 175 W, PV modules can themselves be connected together to make arrays that could potentially supply several MW of power.



Photovoltaic Cell Types

- Crystalline silicon solar cells
 - o Mono-Crystal
 - o Poly-Crystal
- Thin film solar cells
- Non-silicon compound thin film solar cells





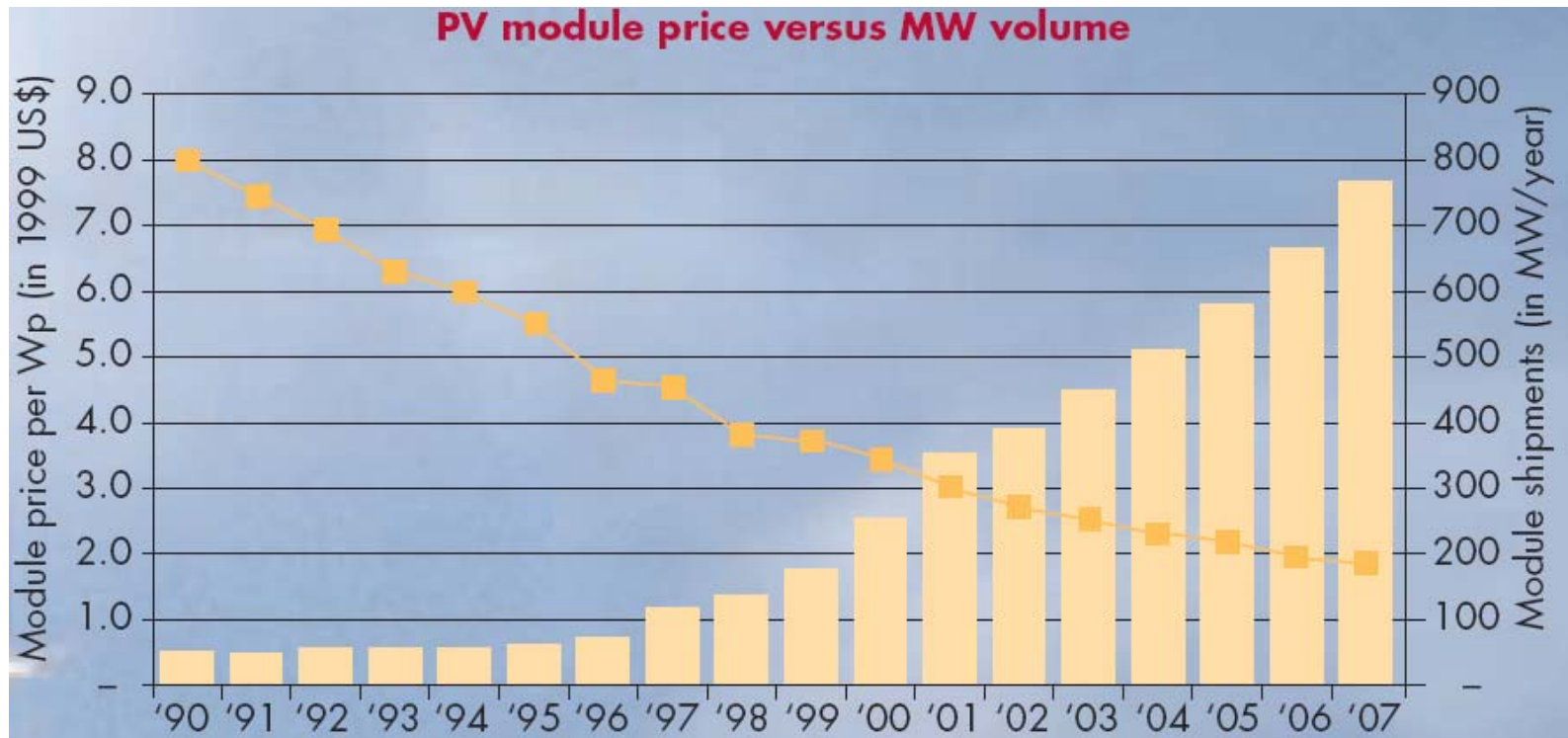
A Dream Unrealized...

- In 1954, Bell Lab scientists displayed the first silicon solar cell at the National Academy of Science in Washington DC
- Bell Lab claimed PV "may mark the beginning of a new era, leading to the realization of one of mankind's most cherished dreams - the harnessing of the almost limitless energy of the sun for the uses of civilization."
- That dream has yet to be realized, due largely to the high cost of solar cell technology



Plummeting Costs

As a result of technological developments, higher demands and governmental support, the costs of providing solar energy have fallen by more than 50% over 10 years.





PV Adds Value to Commercial/Institutional Buildings

- Reliable power for mission critical communications, computers, lighting
- Independence from the electric grid, in stand-alone mode
- Electricity bill savings in certain rate structure situations such as peak demand charges and ratchet fees





Shining Example—CSUN

- 3,000 solar panels at California State University, Northridge (CSUN)
- Student parking lot shade
- Generates majority of energy when it's most needed—between 1:00 and 5:00 pm
- Expected to save the university more than \$50,000 annually
- Reduces ecological impact: US EPA says 225 kW of PV reduces carbon emissions equal to the amount emitted by average 36 passenger cars driving 20,000 miles per year





LEED Rating Contribution

- Innovation 1 pt.
- Renewable Energy 3 pts.
- Optimize Energy Utilization 10 pts.



Questions?